USDA SEDIMENTATION LABORATORY

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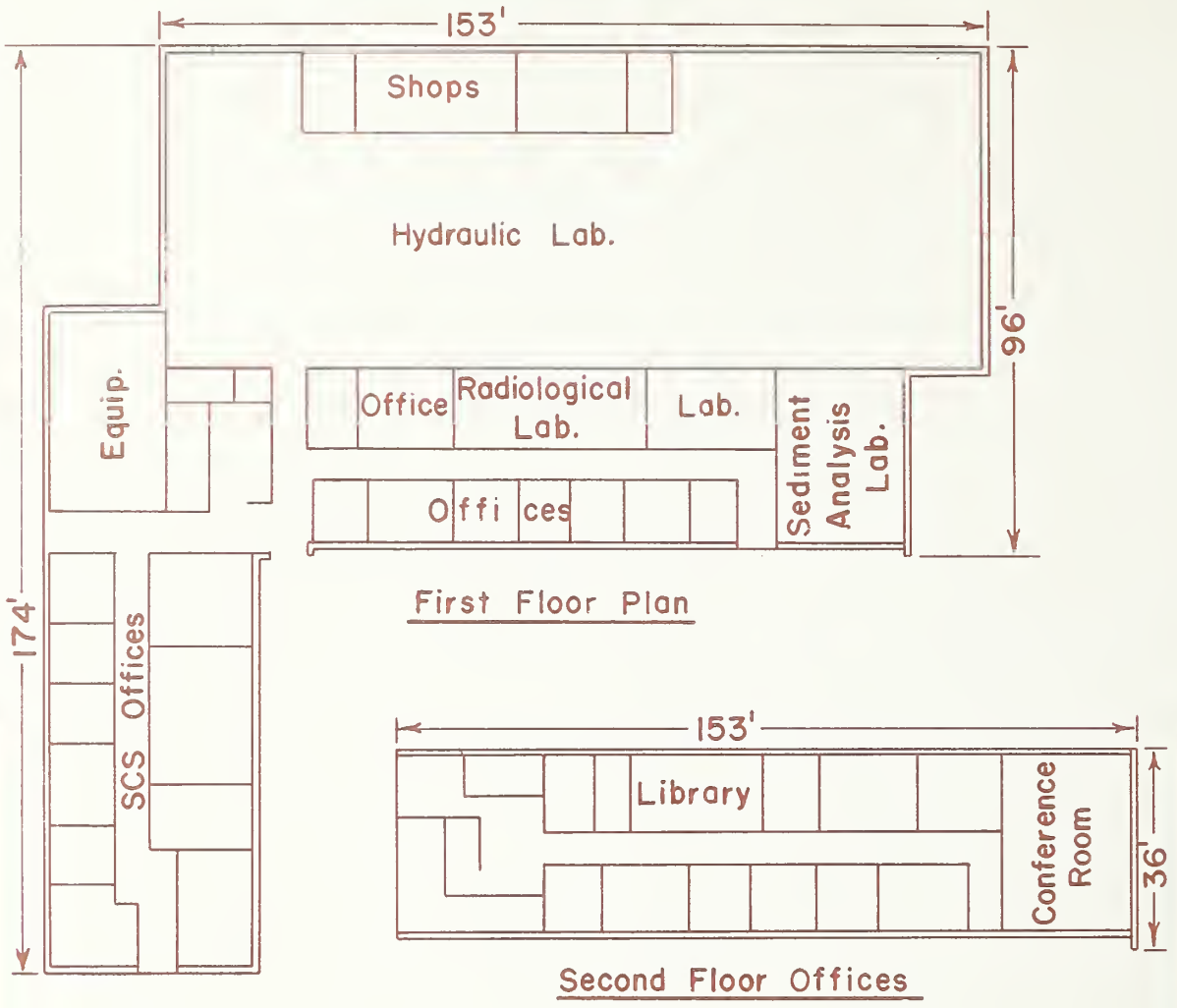


USDA SEDIMENTATION LABORATORY

General Floor Plan

USDA
SEDIMENTATION LABORATORY

The Sedimentation Laboratory at Oxford, Miss., is the only facility in the United States dedicated solely to research in sedimentation. Here, scientists of the U.S. Department of Agriculture, working in cooperation with the University of Mississippi and Mississippi State University, are studying the critical sedimentation problems in the southern loess hills area of Mississippi.

Sedimentation, in its broader aspects, includes detachment, entrainment, transportation, and deposition of soil materials. Rain detaches top soil and washes it into streams. The less pervious subsoil, being exposed, permits water to run off rapidly. The resulting problems may be varied and serious. Erosion occurs. Stream channels become plugged with sediment; above-normal flows spill over the banks and create floods; navigation channels must be dredged; reservoirs lose some of their holding capacity.

HISTORY AND PURPOSE

In 1946 the Soil Conservation Service of the U.S. Department of Agriculture undertook a large-scale flood-prevention project in the Yazoo River basin area in Mississippi. In 1948, a small-scale research project was started at State College, Miss. The research activities were transferred to the Agricultural Research Service in 1953.

In 1956 the project was moved to Oxford, Miss. In 1957 the Congress provided funds for a Sedimentation Laboratory. Construction was begun in 1958 and was completed in 1959.

The research program of the Sedimentation Laboratory includes coordinated field and laboratory studies of sedimentation processes and the factors affecting stream channel equilibrium. Such research provides knowledge for assessing sedimentation and channel problems and for designing corrective measures in programs for watershed development and protection. The research is complex and requires unique facilities and competence.

The Sedimentation Laboratory was established in the Yazoo River basin area in Mississippi for studying the critical sedimentation problems of that section. However, the Laboratory also serves as a national center for sedimentation research, and its findings extend into other parts of the country through associated studies in various regions.

The hill portion of the Yazoo River basin extends over some 6,500 square miles in Mississippi. Included in this area is the Pigeon Roost Creek watershed, about 30 miles north of the Laboratory, which covers 117 square miles. Also included is the 1,000-acre drainage area of Laboratory Creek, which flows through the back of the property on which the Sedimentation Laboratory stands.

Stream gaging and sediment sampling stations have been installed at 13 locations on the Pigeon Roost Creek watershed. The gaging stations are on watersheds that vary from 100 acres to 117 square miles, and all are included in the 117-square-mile area.

More than 30 rain gages record rainfall intensities and amounts in the watershed. Four small experimental cropland watersheds, 1 to 4 acres in size, and a series of fractional-acre pasture plots are operated nearby on lands of the Holly Springs Branch of the Mississippi Agricultural Experiment Station.

Throughout most of this area, loessial soil overlies Coastal Plain formations. Because the soil is highly erodible, channel instability is serious here. The erosional processes have produced quantities of sand that have filled stream channels, sanded valleys, damaged reservoirs, and caused floods.

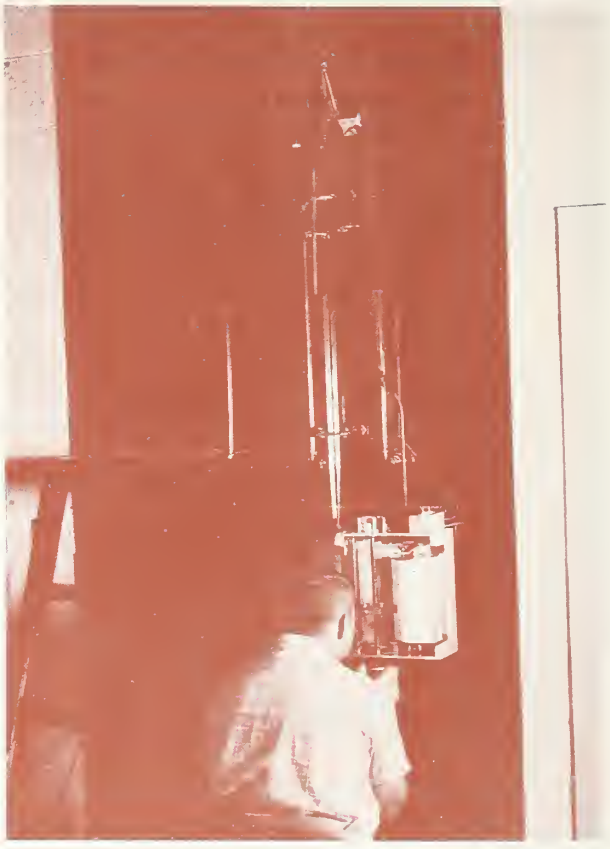
The facilities at Oxford provide an opportunity to study sedimentation under both laboratory and field conditions. Aspects of problems that cannot be isolated or adequately measured in the field under natural conditions are studied in the laboratory under controlled conditions. Concepts and theories developed in the laboratory are tested and evaluated in the field.

STAFF

More than 50 professional and subprofessional persons are employed at the Sedimentation Laboratory, which is administered by a director. The staff includes hydraulic and agricultural engineers, geologists, soil scientists, statisticians, scientific aids, stenographers, mechanics, and building maintenance assistants. In addition, there are a number of part-time employees, mostly students from the University of Mississippi. All the positions are within the Federal Civil Service.

Many of the staff members are enrolled in courses at the University. Four of the professional staff are on the University faculty and serve primarily as consultants or advisers to graduate students.

The Sedimentation Laboratory is administered by the Southern Branch of the Soil and Water Conservation Research Division of the Agricultural Research Service. Research on sedimentation is carried on by other Branches of the Division in most sections of the country where critical sediment problems exist. Laboratory staff members are available for consultation on request from any Branch of the Division.



Scientists determining size distribution of sand in suspended sediment samples by visual accumulation tube method.

FACILITIES FOR RESEARCH

The Sedimentation Laboratory consists of a two-story building with a floor area of about 23,000 square feet. This building contains three laboratory areas and provides offices for the ARS employees and the State Design and Construction engineers of the Soil Conservation Service. Specialized laboratory facilities are provided for workers engaged in both indoor and field studies.

Three laboratories make up the basic facility: A Sediment Analysis Laboratory for processing sediment and soil samples obtained in the field and in the laboratory; a Hydraulic Laboratory for flume and model experiments on sediment transport; and a Radiological Laboratory for developing techniques and uses of radioactive isotopes in sedimentation research.

SEDIMENT ANALYSIS LABORATORY

Studying factors affecting sediment yields from agricultural watersheds is an important part of the research program of the Laboratory. Sediment yield is the amount of sediment carried out of a watershed. Information about sediment yield is needed for planning and designing flood-conveyance channels, reservoirs, ponds, dams, irrigation canals, and drainage ditches.

To obtain information about sediment yield and transport in natural watersheds, technicians take soil samples from fields and streams in the Pigeon Roost Creek watershed. These samples are analyzed in the Sediment Analysis Laboratory to determine physical and chemical characteristics.

The analyses carried out include concentrations, specific gravities, particle-size distribution, plastic and liquid limits, and volume weights. In addition, studies and analyses are made to determine other characteristics, such as moisture-holding capacity of soils, soil permeabilities, clay mineral content, and void ratios. Thousands of sediment samples are analyzed in this laboratory each year.

Sediment samples and representative laboratory equipment in the Sediment Analysis Laboratory.

HYDRAULIC LABORATORY

The Hydraulic Laboratory occupies 9,300 square feet. Here, model studies and experiments on all phases of sedimentation can be carried out. This laboratory houses two sediment-transport flumes that are used by ARS researchers to study basic factors affecting sediment transport.

The larger flume is 100 feet long, 4 feet wide, and 2 feet deep. Its slope can be regulated to duplicate the slope of local streams, and its depth and discharge can be controlled. A large pump circulates up to 8,000 gallons of water-sediment mixture a minute through the flume. By use of special instruments, scientists can measure accurately the variables involved.

The flume has a 6-inch layer of sand on the bed similar to that of natural streambeds in the Yazoo River basin. Thus it is possible to study, under controlled conditions, such problems as streambed configuration and the movement of sand particles on the surface of the streambed and just above.

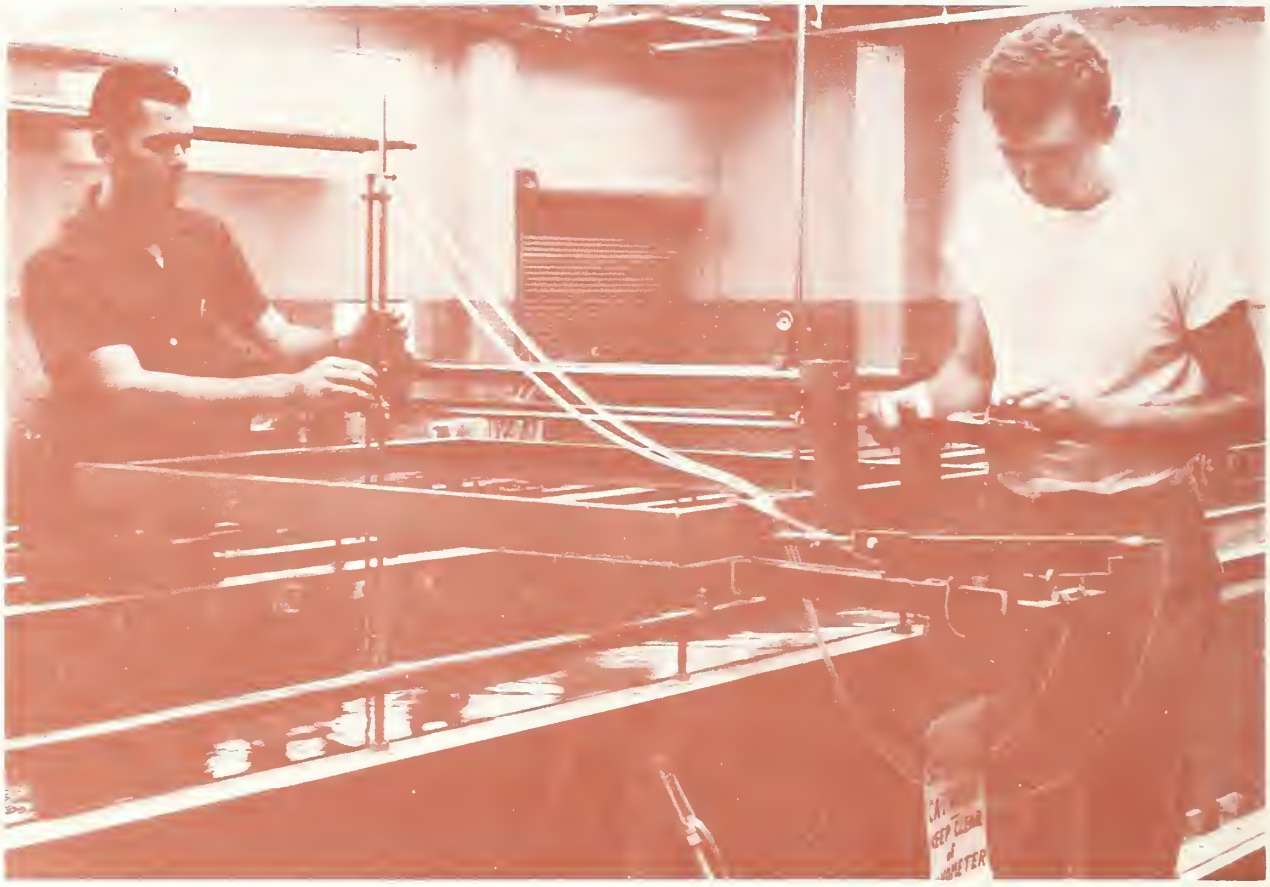
The smaller flume, which is just being placed in operation, is 50 feet long, 14 inches wide, and 12 inches deep. Its maximum discharge is 1,570 gallons of water per minute.

The Dual Channel Stream Monitor, an electronic instrument developed at the Colorado State University under contract for the U.S. Department of Agriculture, is used to continuously record the profile of the water surface and sandbed in the 100-foot laboratory flume. The instrument can also be used in natural streams such as Pigeon Roost Creek and Laboratory Creek.

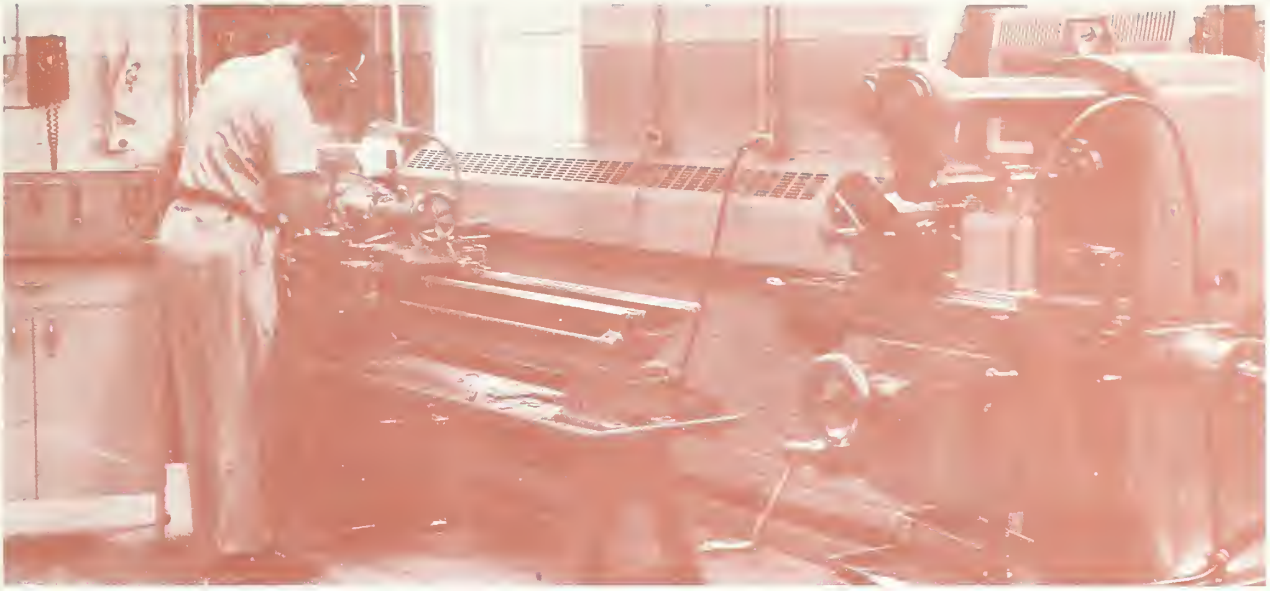
In addition to the sediment transport flume studies, experiments are carried out on bank stability, erosion of cohesive materials, aquifer permeabilities, and effects of laminar and turbulent flow on particle movement.

The small, well-equipped, specially designed machine shop is an important part of the Sedimentation Laboratory. It is often necessary for research workers, particularly those in the Hydraulic Laboratory, to design and construct special instruments and tools that are not available commercially. The point-gage carriage, the sampling devices, and the pitot tubes used with the flumes were designed by staff members and constructed in the machine shop.

One hundred-foot flume in the Hydraulic Laboratory, used to study sediment transport under controlled conditions.



Velocity measurements in the 100-foot flume being taken with a pitot-static tube and an inclined differential manometer. The traveling instrument carriage rolls on accurately alined rails and is equipped with instrument supports in horizontal and vertical planes so that an instrument may be supported at any point in any section along the flume. Up to four instruments can be handled at once on this carriage.



Research machinist at work on a 13-inch toolroom lathe. Facilities are available for various types of metalworking and woodworking.

RADIOLOGICAL LABORATORY

In the Radiological Laboratory, nuclear techniques are used to help solve many research problems, including the movement of sand particles from the point of detachment to final deposition. A technique has been developed for tagging sand particles with scandium 46. Barium 140, silver 111, cobalt 60, and other suitable isotopes are also used for tagging particles.

Because different isotopes have different and characteristic emissions, it is possible to distinguish one from another. It is also possible to tag several sediment particles of different sizes and to follow their movements simultaneously. Special equipment is needed for this purpose.

Tracing soil particles is perhaps the first attempt to determine how fast and how far eroded soils travel under varying environments. This research will make it possible to devise ways of controlling sediment and minimizing damage.

Radioisotopes are also used to trace the movements of subsurface waters in a watershed. Samples are taken periodically at given points for analysis. Because the injected samples are diluted considerably before they are collected downstream, detection of the radioisotopes must be made at the laboratory where sensitive radioactivity detection apparatus is available.

Radioisotopes are used in measuring the density of reservoir sediment. The usable life of a reservoir depends largely on the rate of sediment accumulation and the efficiency of the reservoir in retaining sediment. Both the mass and the density of the sediment affect the storage capacity of a reservoir. Reservoir sediment studies, therefore, include measurements of both volume and density of the sediment deposits under a variety of conditions.

Radioactive solutions being transferred to planchets to determine the radioactivity present. Personnel are required to wear rubber gloves while handling these solutions and film badges to record the amount of radiation received.

Proportional and scintillation types of radiation detectors used in the Radiological Laboratory. Proportional system (left) has been combined with a sample changer to count alpha-beta radioactivity automatically. Scintillation spectrometer (right) is used in identifying and measuring intensities of radioisotopes emitting gamma rays. An instrument of the latter type is currently being used in field studies to measure tagged particles.

The gamma density probe is used to determine the density of underwater deposits. Without disturbing the sediment, it measures the decreases in gamma-ray intensities caused by increases in densities of the medium surrounding the probe. Measurements may be made from a raft or a boat, or in shallow water by wading. They may be made in waters up to 75 feet deep. In soft deposits, the probe must be supported at the desired measuring depths. In hard, consolidated deposits, pressure must be applied to force the probe into the sediment.

Scientists are working on the development of a two-probe system for measuring sediment density that will make it possible to measure densities in small horizontal bands.

Research workers measuring the density of sediment in a reservoir with a gamma density probe. Worker on left is operating the scaler, which records the signals transmitted from the probe (right center) through the cable (left).

FIELD OPERATIONS AND DATA ANALYSES

Field studies are an integral part of the research program at the Laboratory. Intensive field studies are currently in process in the channels and watersheds of Pigeon Roost and Laboratory Creeks, and at the Holly Springs Branch of the Mississippi Agricultural Experiment Station. Field studies are also conducted in the Barber Creek area near Watkinsville, Ga., and at several other locations in the country. Numerous field studies are being made of stream channel conditions, reservoir sedimentation, and gully development.

In their efforts to determine the laws governing transportation and deposition of solid particles by water, ARS scientists are using various devices for sampling sediment in the Pigeon Roost Creek watershed.

The US D–49 suspended sediment sampler is used at all gaging stations in this watershed for collecting samples above wading stages. This sampler is suspended from a steel cable attached to a sounding reel mounted on a cable car, or from a collapsible rig on a truck when used on a bridge. At small stations where footbridges are used, the sampler is supported from a sounding reel mounted on a portable dolly.

The US DH–48 suspended sediment hand sampler is used at all stations for collecting samples at wading depths only.

The US BM–54 sampler is designed to collect a bed material sample from the top 2 inches of a streambed. Samples are collected at various points to give a complete representation of the existing bed material. Analyses of these samples indicate any change in particle size of the top 2 inches of bed material during a particular runoff period.

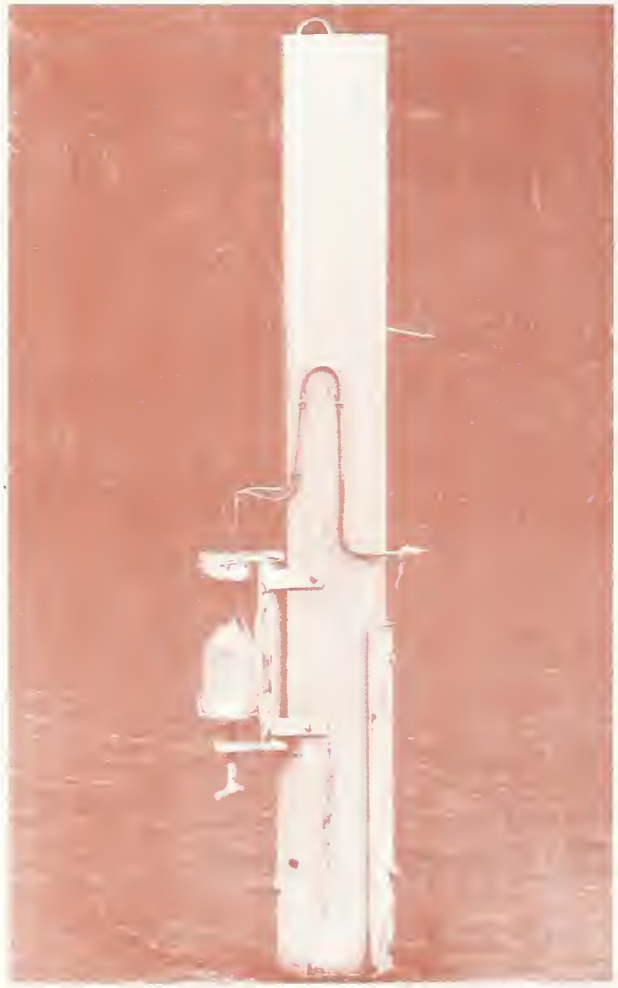
The automatic single-stage sediment sampler has been installed on several of the large streams in the watershed. Samples collected by this means are used to augment those collected by the technicians when on site during a runoff period. The automatic sampler is inexpensive but requires considerable maintenance.

Further installations are planned, including a traveling bridge on Laboratory Creek suspended just above the water surface that will give access to the streambed for 30 or 40 feet. A structure to cause suspension of the bedload and thus permit a true sampling of all material in transport is also planned. These installations will make it possible to obtain more information on the unmeasured portion of the total sediment load and on the interrelationship of channel hydraulic factors and sediment transport.

US D–49 suspended sediment sampler in use on Pigeon Roost Creek.

Hydrographer using the US DH–48 suspended sediment hand sampler to obtain a sample of streamflow. Sample will later be analyzed for sediment content.

US BM–54 bed material sampler currently in use at gaging stations in the Pigeon Roost Creek watershed.

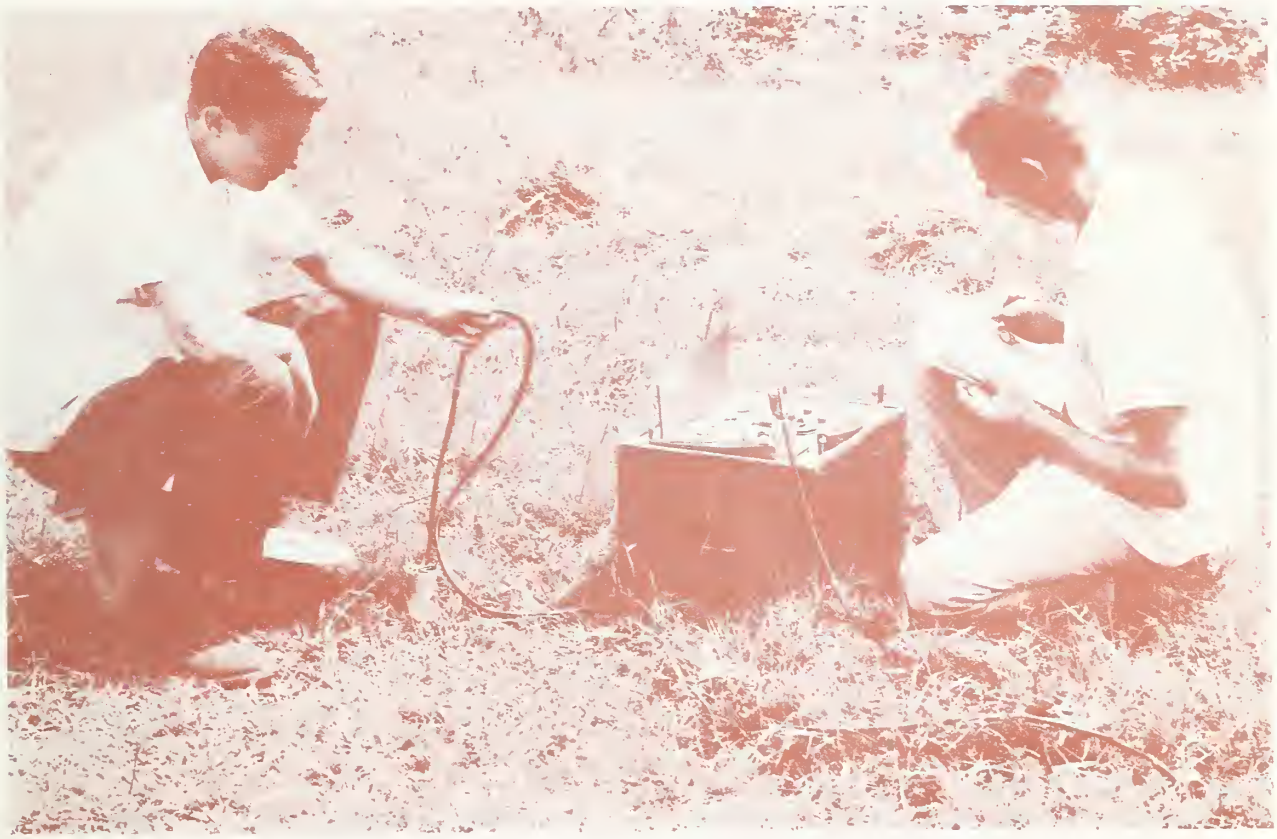


Automatic single-stage sediment sampler for use in high water velocities installed at several gaging locations in Pigeon Roost Creek watershed.

Discharge and sediment sampling station on Laboratory Creek.

Hydraulic engineer measuring base flow in Pigeon Roost Creek watershed. Accurate measurements and analysis of base flow are an important part of ground-water investigations in the area.

Typical location along Hudson Creek. Bank material is being sampled where undercutting occurred during high flow. Undercutting will increase until the bank sloughs off, as is shown at the right of the picture.



Laboratory personnel using neutron equipment to determine soil moisture. Note top of access tube with cable connecting probe to scaler, which is being read by observer on right.

Research technician interpreting data for combining measured sediment concentrations and stage-discharge records. Extensive study and analyses of charts, data tabulations, and computer results are necessary in preparing research reports.

Electronic computer at the University of Mississippi used to compute and analyze data for scientists at the Sedimentation Laboratory.

Suspended sediment samples are collected during storm runoffs at the 13 gaging and sampling stations within the Pigeon Roost Creek watershed. They are correlated with continuous water-stage recorders and concurrent discharge measurements. All pertinent sampling information, including sample weight, is cataloged; and sediment loads are computed. For special studies, additional analyses are made for particle-size distribution of both sand and fines.

Transportation of sediment occurs in two ways—as suspended load and as bedload. The suspended load is distributed throughout the cross section of flow. The bedload slides, rolls, and bounces along the bed. The amount and types of bedload moving with a stream are related directly to the flow. These sediment loads have an important bearing on the stability of channels. Because of the physical limitations of the standard samplers, it is not possible to sample bedload transport at normal gaging sites.

Determining the total sediment moved is further complicated by the lack of continuity in the stage-discharge relationship of some sandbed streams. Two waterflow quantities can occur at a given stage, depending on the material in motion and the configuration of the streambed.

In addition to samples taken in Pigeon Roost Creek, discharge measurements and sediment samples are taken periodically in Laboratory Creek. An intensive study of sediment transport and related channel characteristics is underway.

Members of an engineering field party measuring entrenchment of channelbed a short distance downstream from a small dam near Oxford. The tape across the channel shows the location of the pre-dam channelbed, 7½ feet above the present bed. The pronounced deepening is still limited to this area, but some entrenchment is found 7,500 feet downstream from the dam.

Samples of sediment from the Hudson Creek channel near Oxford are being studied to determine the relationship between bank stability and constituent material. Hudson Creek was selected for this study because it represents typical conditions of bank instability. The bank material varies from a sand to a sandy clay with a continuous 3-foot-deep silt mantle. Twenty-five years ago the channel was approximately 3 feet deep. Today it is 12 to 15 feet deep and 30 feet wide in some places. Currently, one or two crop rows are lost each year by erosion of the bank material, and considerable gullying occurs in the tributaries.

Continuous data on soil moisture are needed to estimate watershed moisture conditions and to determine water balance in watersheds and effect on sediment delivery ratio. Installations have been made on various cover, slope, and soil complexes to provide moisture data to 10 or 20 feet. Readings are usually taken at each foot depth once or twice a week.

Studies of runoff and sediment production from small, single-cover watersheds are underway to provide information about the uplands of the Yazoo-Tallahatchie River watershed and similar areas. These studies will be useful in predicting runoff and sediment from ungaged watersheds.

Data from these studies are analyzed and compared with data from small, fractional-acre plots and from much larger watersheds. Efforts are being made to develop methods for projecting sediment and hydrologic records from small areas to large areas.

Engineers measuring amount of sediment that has accumulated in an arm of a reservoir under study. The 311-acre drainage area contains about 50 badly gullied acres. The dam is a drop inlet type desilting basin constructed in 1951, when detailed surveys were made. Resurveys are made periodically to determine sediment yield from the watershed.

Soil scientist mapping gully in Pigeon Roost Creek basin.

Typical weather station at the Sedimentation Laboratory. Measurements are taken of wind, temperature, humidity, pan evaporation, and solar radiation.

Statistics on sediment yield for the different watersheds are compiled by the Records Section of the Laboratory. In cooperation with the Engineering School of the University of Mississippi, these statistics are being processed on an electronic computer. Use of this computer makes it possible to handle large volumes of data and to compare these with data from other stations and other watersheds.

The Field Office at Holly Springs operates on a 24-hour basis to insure the collection of comprehensive data in the field. Thus it is possible to check each storm center and take on-site readings whenever a storm occurs.

An important phase of the research program is the study of factors affecting reservoir silting. This involves surveys and resurveys of various reservoirs, including the measurement of sediment deposits in the permanent and flood-control pools and in the channels and valleys upstream from the backwater.

Many small sediment trap dams have been constructed by the Soil Conservation Service near Oxford. Entrenchment of the channel downstream from the dam may be one result of this type of construction. This entrenchment is related to the reduction of sediment load because of sediment retention by the dam and the change in the normal flow pattern created by the dam and reservoir.

Sedimentation Laboratory scientists are attempting to determine the gross erosion and sediment delivery ratios over the entire Pigeon Roost Creek watershed. Delivery ratio is the relationship between gross erosion and measured sediment passing a gaging site on a stream channel.

On-site readings of such factors as slope variables, land cover, and type of gullies are taken. Periodic resurveys are made to determine change in land use that might affect gross erosion. Treatment measures such as debris collection basins in the gullies are studied.

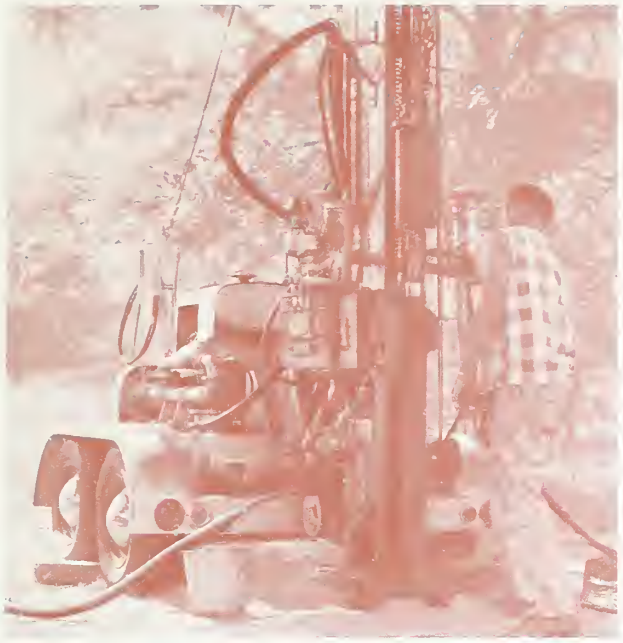
Information gained from this work will be valuable to engineers in planning and building dams.

As part of the hydrologic studies at the Laboratory, rainfall data are collected at the 31 stations scattered throughout the Pigeon Roost Creek watershed. The data are used to determine the hourly precipitation for each storm in the watershed area. Rainfall is correlated with the corresponding runoff and sediment yield on a daily, monthly, and annual basis, as measured at the gaging stations.

Small H flume with water-stage recorder and Coshocton wheel sampler. Hose from the sampler leads to a collecting tank. This installation is used to measure runoff and soil loss from the fractional-acre plot shown in the background.

Modified Parshall flume with water-stage recorder, "silt box" or sediment basin, Iowa slot-type sampler, and sampling tanks. This installation is used to determine runoff and sediment production from a 1.5-acre cultivated watershed on the Holly Springs Branch of the Mississippi Agricultural Experiment Station.

Observer servicing rain gage No. 7 of the Pigeon Roost Creek watershed.



Special drilling rig, with both vacuum and pressure equipment, used to drill holes for exploring subsurface strata and ground-water levels in the Pigeon Roost Creek watershed.

At the Holly Springs Branch of the Mississippi Agricultural Experiment Station, runoff and soil loss are measured from 28 plots ranging in size from 1/50 to ¼ acre with slopes of 2½, 5, and 10 percent. Eight of these plots are in permanent pasture, 18 are cultivated, and 2 are maintained in a bare, cultivated condition. Poor and improved land management are practiced on both the pasture and the cultivated plots. Attempts are made to evaluate the effects of management, cover, slope, and other factors on soil and water losses.

Studies of ground water in the Pigeon Roost Creek watershed are being made. The determination of ground-water movement velocities and quantities is an important factor in determining the basin water balance.

Hydraulic engineers and geologists measure base flow to determine ground-water storage capacity, movement, and loss. Effects of soil, topography, climate, and land use on ground-water storage are studied. A special rig, capable of drilling 100 feet into quicksand, furnishes soil samples for study of subsurface strata and underground water paths.

A LOOK AHEAD

A better understanding of the many factors affecting sedimentation and stream channel equilibrium will contribute much toward using and protecting our watershed resources more effectively. At the USDA Sedimentation Laboratory, research is geared to acquiring both fundamental and applied knowledge. The program is necessarily a long-range one. Ultimately, the results will help insure the best use of our two most vital resources—soil and water.

VISITORS WELCOME

Visitors are always welcome at the Sedimentation Laboratory. Arrangements for conducted tours may be made through the office of the Director. The Laboratory is open daily except Saturdays, Sundays, and holidays.

The Laboratory is located at Oxford, Miss., which is 59 airline miles and 75 highway miles south of Memphis, Tenn.

LOCATION MAP
USDA SEDIMENTATION LABORATORY
OXFORD, MISS.

Washington, D.C.

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